
The Trans-Iron Galactic Element Recorder (TIGER)

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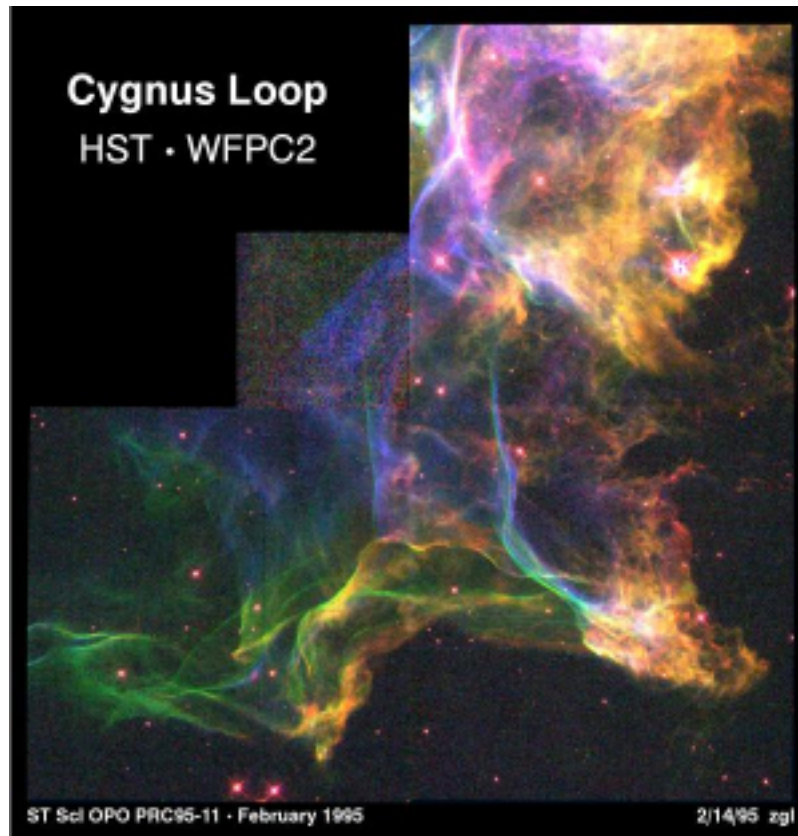
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TIGER Science Objectives



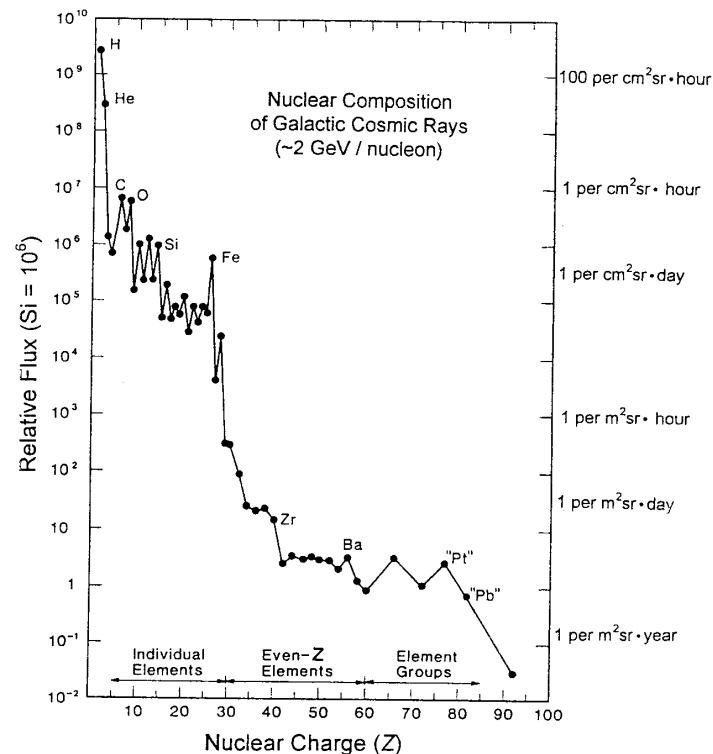
- Study nucleosynthesis of galactic cosmic ray source material for $26 < Z < 40$.
- Compare elemental patterns in galactic and solar material to test galactic evolution models.
- Study cosmic ray acceleration selection effects to determine if the GCR are accelerated out of the gas or grain phase of the ISM.

TIGER Science Requirements



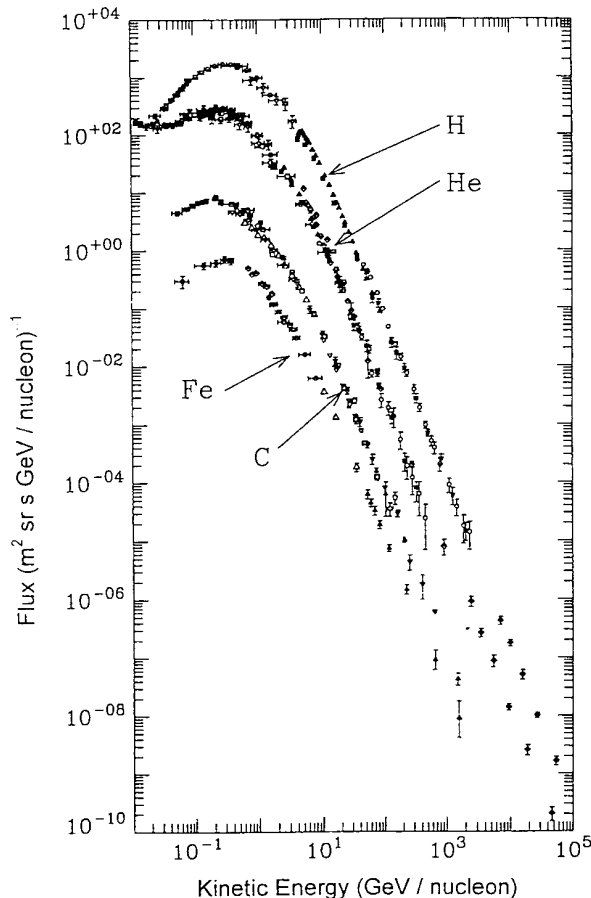
- Excellent charge resolution, <0.25 e.
- Large collecting power to obtain sufficient statistics
 - * large area
 - * long duration
 - * high latitude ($> 30^\circ$)
 - * large energy range
- Low overburden to minimize nuclear interactions

Cosmic Ray Abundances



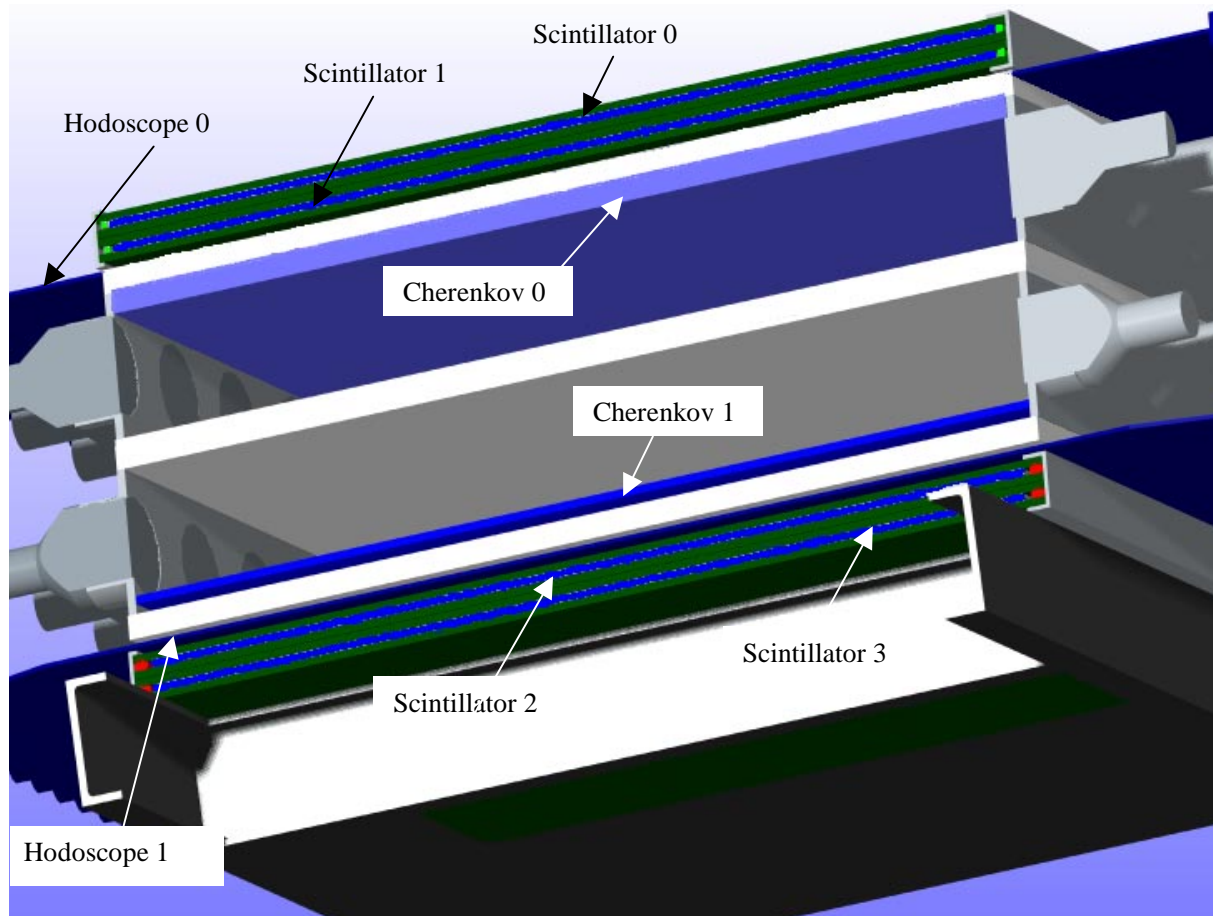
- There is a rapid drop in GCR abundances for $Z > 26$
- There is a second drop for $Z > 40$
- Elements to be measured by TIGER have a large primary fraction
- Note $\sim 1 / \text{m}^2\text{sr}\cdot\text{day}$ for $30 < Z < 40$

Cosmic Ray Energy Spectrum

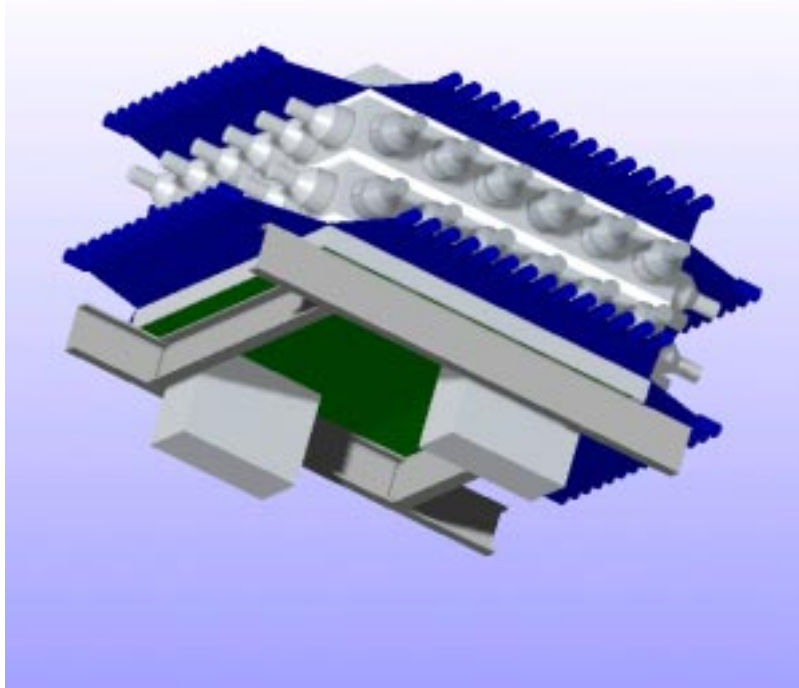


- Most Cosmic Rays have energies around 1 GeV
- Geomagnetic cut-off has a significant effect on number of particles per day
- Solar modulation further reduces number of particles for solar max time period, but results in better source abundance measurement

TIGER Detector Cross-Sections

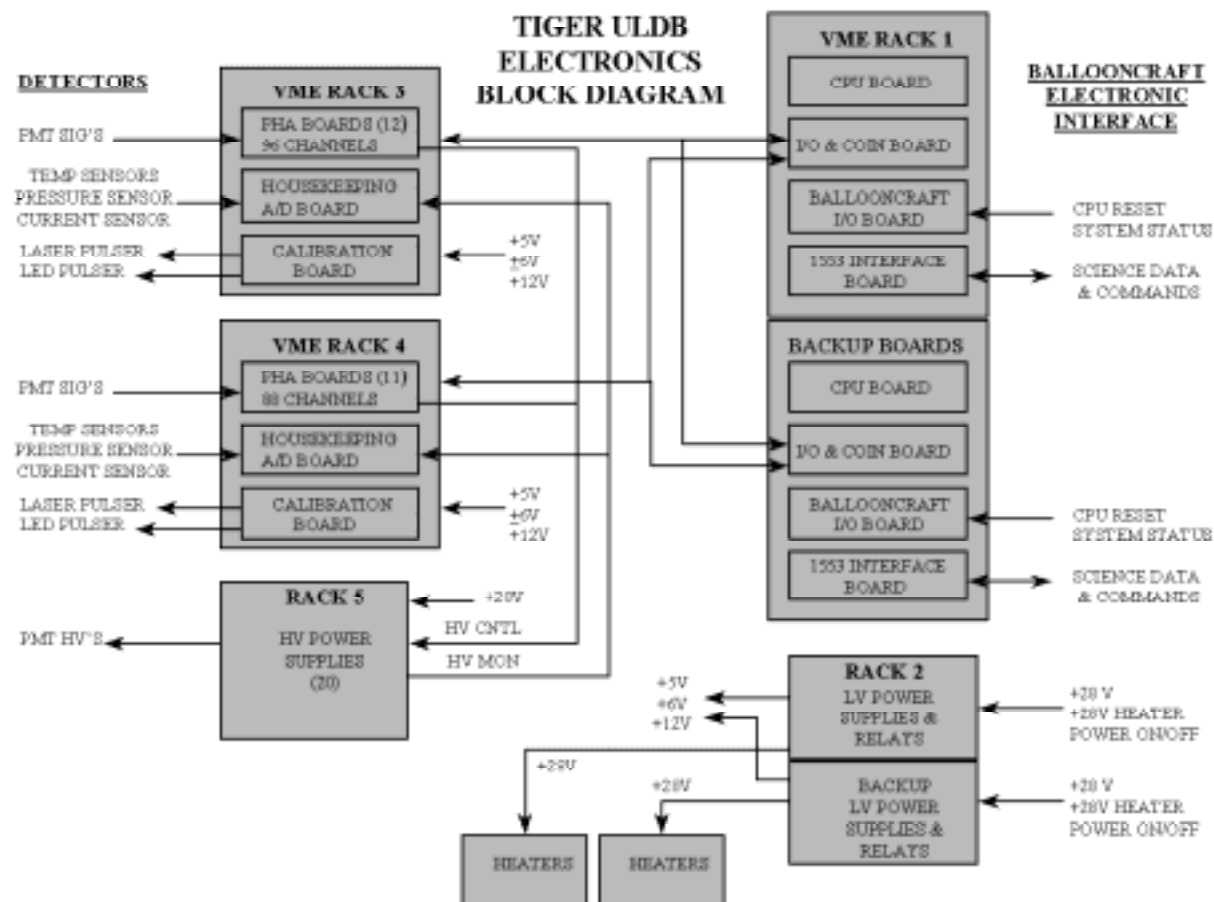


TIGER Experiment Cross-section

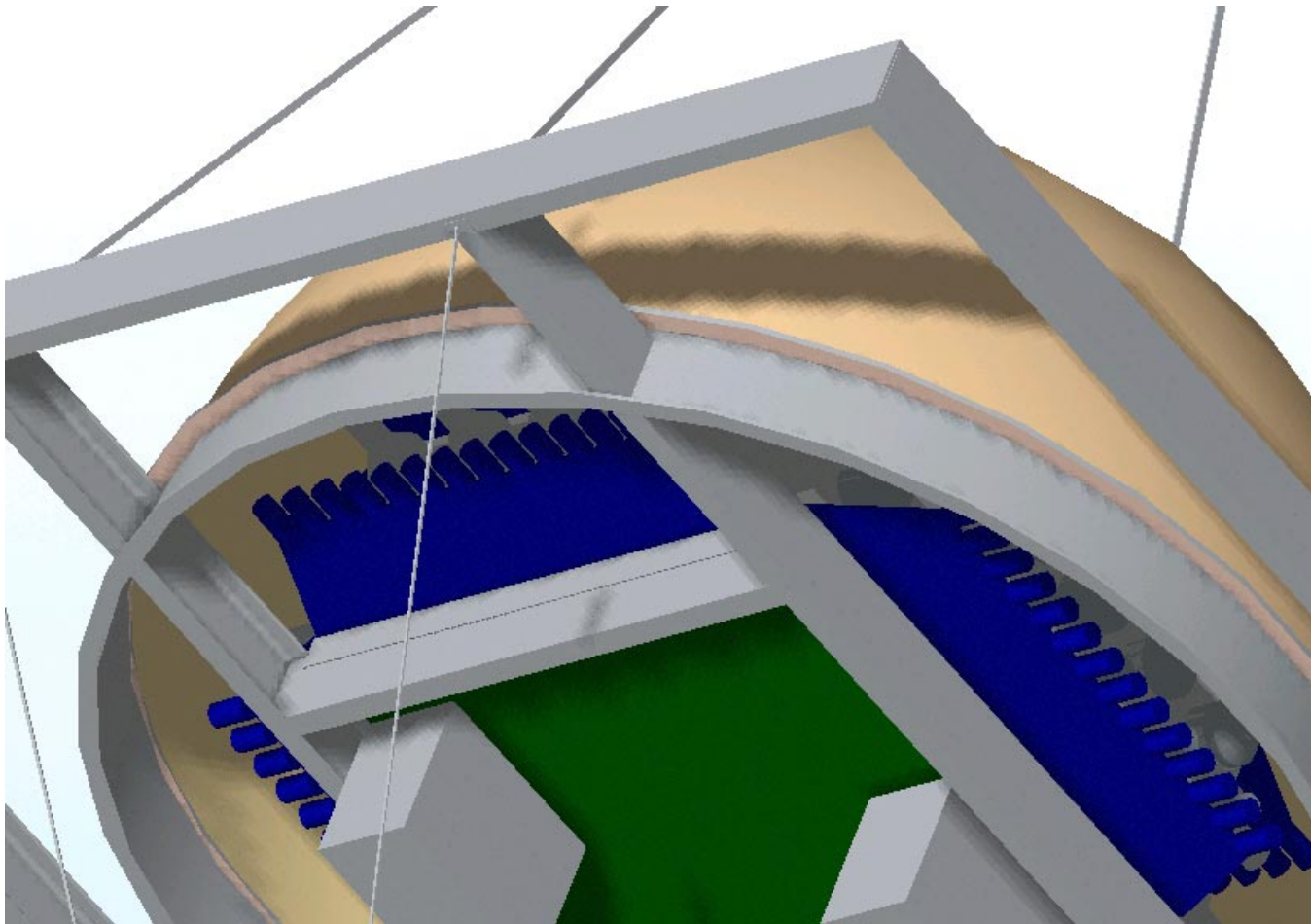


- Detectors mount on top of main structure, filling most of the upper half of pressure vessel
- Electronics mount to bottom of main structure
- Bottom half of PV is mostly empty.
- Heat dissipation is concentrated in electronics.

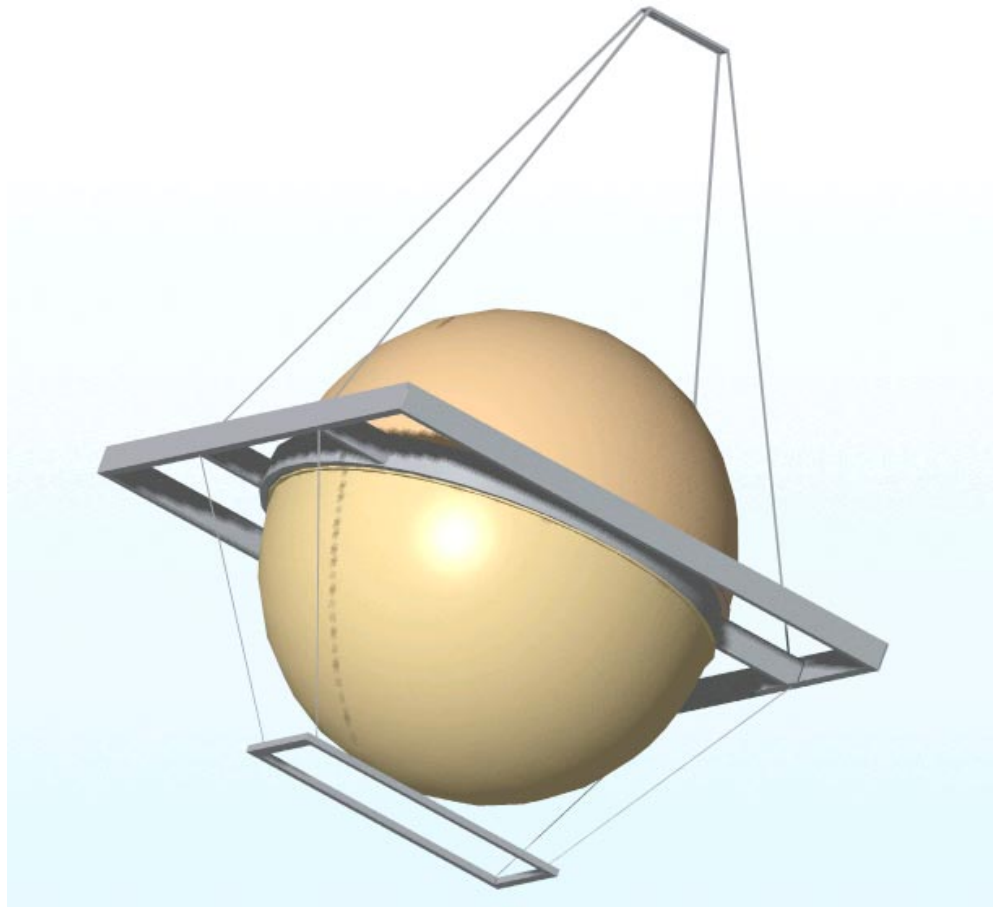
TIGER Electronics



Primary Structure - Detail



TIGER2000 Primary Structure and Pressure Vessel



TIGER2000 Resource Requirements - Overview

| Resource | Average Requirement | Peak Requirement |
|------------|---------------------|------------------------|
| Mass | 540 kg | N/A |
| Power | 222 Watts | 522 Watts (night) |
| Telemetry | 4.4kbps | 5.7 kbps |
| Commanding | < 1 per day | 20 during LOS checkout |

Power Allocation

| Sub-system | Power (W) |
|-------------------------------|-----------|
| Ballooncraft I/O | 10 |
| CPU (Science) | 5 |
| PMT A/D Conv. | 28 |
| Logic Board | 4 |
| Auxiliary Unit (housekeeping) | 3 |
| LVPS (0.8 eff of above power) | 12 |
| HV Power Supply | 60 |
| Heaters (Daily average) | 100 |
| TOTAL | 222 |

Mass Resource Requirements

| Sub-system | Total Mass (kg) | Actual | Extrapolated from TIGER | Calculated |
|------------------------------|-----------------|----------|-------------------------|------------|
| S0 Detector | 21.6 | 14.5 | 4 | 3.1 |
| S1 Detector (same as S0) | 21.6 | 14.5 | 4 | 3.1 |
| S2 Detector (same as S0) | 21.6 | 14.5 | 4 | 3.1 |
| S3 Detector (same as S0) | 21.6 | 14.5 | 4 | 3.1 |
| C0 Detector | 75.0 | 75.0 | | |
| C1 Detector | 78.0 | 78.0 | | |
| Hodoscope | 28.4 | 14.7 | 11.1 | 2.6 |
| Detector Supports | 22.0 | 22.0 | | |
| Main Structural Members | 26.6 | | 26.6 | |
| Cross Structural members | 10.5 | | 10.5 | |
| Belly-Band | 40.0 | | | 40.0 |
| Pressure Vessel Domes | 55.0 | 55.0 | | |
| Pressure Vessel Hardware | 9.2 | | 9.2 | |
| Electronics Support | 9.5 | 9.5 | | |
| Electronics | 37.5 | | 37.5 | |
| Cables | 22.0 | | 22.0 | |
| Thermal | 30.0 | | | 30.0 |
| Misc Hardware | 10.0 | | | 10.0 |
| | | | | |
| TOTAL | 540.1 | 312.2 | 132.9 | 95.0 |
| | | | | |
| Fraction of total / category | | 0.578014 | 0.2460422 | 0.175944 |

Telemetry Resource Requirements

| Data Type | Packet Size (bytes) | Transmission Frequency |
|------------------------------|--------------------------------|-----------------------------------|
| Science | 1648 | ~ 3 / sec |
| Calibration | 2608 | 4 / min |
| High Voltage Monitor & Rates | 1008 | 4 / min |
| Analog Housekeeping | 664 | 0.5 / min |
| Digital Housekeeping | 984 | 0.125 / min |
| Command Response | 256 | < 1/day |

Flight Profile Requirements

| Latitude | | Altitude | | Minimum Duration for primary science (days) |
|--------------|--------------|---------------|----------------|---|
| Minimum (°S) | Maximum (°S) | Minimum (kft) | Maximum (kft) | |
| 43 | 43 | 115 | 115 | 54 |
| 43 | 43 | 105 | 105 | 78 |
| 35 | 35 | 115 | 115 | 88 |
| 35 | 43 | 115 | 115 | 62 |
| 30 | 43 | 115 | 115 | 65 |
| 30 | 43 | 110 | 110 | 80 |
| 30 | 43 | 105 (6 hours) | 115 (18 hours) | 74 |

Summary

- TIGER requires sufficient statistics to accurately measure the abundances of $Z = 34$, 37, and 38 (~ 2 million Fe nuclei).
 - * Very large collecting power (area * exposure time)
 - * Large energy range including low energy particles
 - * High latitude to benefit from lower geomagnetic cut-off ($> 30^\circ$)
 - * Low overburden, both instrument and atmosphere (low mass detectors and altitude $> 115,000$ feet)
- Require excellent charge resolution to identify odd- Z elements